Remarks

The Applicants thank the Examiner for the opportunity to discuss this application in the in-person Interview conducted on Oct. 29, 2004.

Prior to this amendment, claims 1-62 were pending in this case. The Office Action mailed Sept. 13, 2004 rejected all claims, asserting, in pertinent part, the following claim rejections:

(I.) Claims 1-3, 6-9, 26-27, 32-34 and 37-40 were rejected under 35 U.S.C. 102(b) as being allegedly anticipated by Kawakami et al. (5,613,261). The Action asserted that Kawakami '261 "discloses a cleaner comprising a drive system (see figures 1 and 2), a controller 20, a debris sensor 19, and a processor (CPU, col. 3 lines 12-57). See figure 6 for pattern of movement."

(II.) Claims 13-31, and 44-62 were rejected under 35 U.S.C. 102(b) as being allegedly anticipated by Crotzer (5,910,700), WO 95/30887, Schallig et al (6,076,227) and Japanese Patent 6-38912. The Action asserted that these references "disclose cleaning apparatus comprising a cleaning pathway, a piezoelectric sensor and a processor to change an operative mode of the cleaning apparatus."

(III.) Claims 4, 10-11, 35, and 41-42 were rejected under 35 U.S.C. 103(a) as being allegedly unpatentable over Kawakami '261 in view of Hoekstra 5,542,146 or 5,515,572. The Action asserted that Hoekstra '146 and '572 "disclose vacuum cleaner control systems comprising spaced apart dust sensors" and that "since Kawakami et al. disclose at column 4 line 42 a linear sensor instead of an individual sensor array for more than one sensor, it would have been obvious . . . to provide Kawakami et al. with the spaced apart dust sensors as taught or suggested by Hoekstra."

(IV.) Claims 5 and 12 were rejected under 35 U.S.C. 103(a) as being allegedly unpatentable over Kawakami '261 in view of Hoekstra '572 or '146 "taken with Schallig ['227], WO 95/30887, Crotzer ['700] or Japanese Patent 6-38912." The Action asserts that Schallig, WO '887, Crotzer '700, and JP '912 "teach and suggest piezoelectric dust sensors"; and "since the alternative use of optical or piezoelectric dust sensors for cleaners is taught or suggested by these references, it would have been obvious to provide Kawakami et al with the piezoelectric dust sensor as taught or suggested by these references."

In response, this Amendment cancels claims 1-2, 6-8, 13-16, 32-33, 37-39, and 44-47, and amends the other claims in the case. Each of the grounds of rejection set forth in the Action will next be discussed.

I. Rejection of claims 1-3, 6-9, 26-27, 32-34 and 37-40
as being allegedly anticipated by Kawakami '261

Kawakami: Kawakami '261 discloses a self-propelled, fluid-based cleaning device having a sensor 37 that allegedly allows it to "thoroughly clean only very dirty areas." The device includes a "mode sensing unit" 34 that "selects the operation travel and cleaning mode in accordance with the results of sensor unit 37" (col. 3, ll. 18-20). Sensor unit 37 includes a "floor reflectivity sensor" 19 that is used to measure "the degree of dirt of the floor surface [ahead of the cleaning elements of the machine] prior to cleaning" (col. 3, ll. 3-9). In particular, the reflectivity sensor 19 includes LEDs 51 and photocells 52. Light from LEDs 51 is bounced off the floor ahead of the cleaning elements of the machine and detected by photocells 52; and a determination of "soil" is made by comparing the output from photocells 52 to "reflectivity data previously stored in memory (col. 3 – col. 4). When "it is determined that dirt is present on the floor", then "careful cleaning mode instructions are issued to driving controller 32" (col. 5, ll. 15-19). "Careful cleaning" mode differs from "normal cleaning" mode in the number of drops of cleaning fluid dispensed, the speed of rotation of cleaning sponges in the device, and the speed of forward movement of the device (col. 3, ll. 27-45).

In short, Kawakami describes the idea of calculating the dirtiness of an area ahead of the cleaning elements of the machine by bouncing light off it, and then comparing the amplitude of reflected light to previously stored reflectivity data. Based on the comparison, Kawakami can select "careful cleaning mode" – more cleaning fluid, faster cleaning sponge rotation, slower forward movement of the device.

No Patterns of Movement: However, Kawakami contains no teaching of "patterns of movement" – and certainly no suggestion of the idea of "selecting a pattern of movement" from "at least one pattern of movement" as that term is used in Claim 1 and the other noted claims, and as explained in the specification (see, e.g., pp. 13-18 and the flowchart of FIG. 8). At the very least, a "pattern of movement" as claimed includes the aspect of controlling the direction of movement of the device in response to the debris signal. Kawakami contains no teaching of controlling the direction of movement of the device in response to a debris signal.

The Action alleges that FIG. 6 of Kawakami shows a "pattern of movement" but in fact, Kawakami contains no statement, explanation or other teaching of a "pattern of movement". The term "pattern of movement", or any similar term, never appears in Kawakami. FIG. 6 of Kawakami shows nothing more than a checkerboard design, presumably a floor, with a domelike figure (11), and an arrow, presumably showing a direction of movement. That is not a pattern of movement, and it is not even a suggestion of a pattern of movement. In discussing FIG. 6, Kawakami states: "FIG. 6 shows

the plan of a floor to be cleaned. When the region to be cleaned includes areas having different reflectivity values, such as that shown in FIG. 6, a map of the reflectivities according to position on the floor surface is stored in memory 92. Thus, by providing the aforesaid memory 92, the degree of dirt of a floor surface can be calculated by detecting the current position of the cleaner by position detector 94 . . . and comparing the output of sensor 91 in comparison unit 93." That is substantially the entire description of FIG. 6 in Kawakami. There is no discussion therein of a pattern of movement in FIG. 6 or any other drawing.

In fact, Kawakami lacks any discussion of how (or whether) Kawakami's cleaning device turns, backs up, spirals, zig-zags, or otherwise how the device moves. As far as movement, there is only the vague assertion in Kawakami that there exists a "speed of forward movement." This is not a teaching or suggestion of "patterns of movement" as that term is used in the referenced patent claims, and there is certainly no teaching or suggestion that a "pattern of movement" be selected in accordance with a debris signal.

As a corollary to this, Kawakami contains no teaching or suggestion of a processor (1) operable to control the drive system to provide at least one pattern of movement and (2) responsive to the debris signal to select a pattern of movement."

No Debris Signal as Claimed: It is also noted that Kawakami contains no teaching or suggestion of a "debris signal indicating that the cleaning apparatus has collected debris" (emphasis added)(see Claim 1 and the other referenced claims). As stated in the present application for patent at p. 1, the term "debris" is used therein to collectively denote dirt, dust, and/or other particulates or objects that might be collected by a vacuum cleaner or other cleaning apparatus, whether autonomous or non-autonomous; and the term "has collected" denotes particulates or other objects that have already been collected. But Kawakami does not teach a device or method for measuring particulates or other objects that have already been collected. Instead, since Kawakami is directed to a "wet", i.e., liquid-based cleaner, in contrast to a vacuum cleaner, Kawakami's measurement is intended to determine whether a floor area ahead of the cleaning elements of the machine has a film of dirt. "If floor reflectivity sensor 19 is provided on the front side of the cleaning unit relative to the direction of advance of the cleaner, the degree of dirt of the floor surface can be detected without hindering the cleaning operation because the cleaning operation can be accomplished while detecting the degree of dirt of the floor surface prior to cleaning" (emphasis added)(col. 2, ll. 2-8). See also col. 4, ll. 26-35 and FIGS. 2, 9 and 10.

Still further, with regard to claims 26-27 (and presumably the corresponding method claims), Kawakami contains no teaching or suggestion of a "debris gradient representative of changes in debris

strikes". For one thing, Kawakami does not speak of debris strikes, nor would its LED and photocell configuration be operationally responsive to debris strikes. Secondly, since Kawakami is a wet cleaner, debris strikes are substantially outside its operating envelope. Third, there is absolutely no teaching of calculating a debris gradient (i.e., the first derivative of debris strikes) as discussed in the present application for patent.

Accordingly, Kawakami neither teaches nor suggests the combination set forth in the referenced claims.

II. Rejection of Claims 13-31, and 44-62
As Being Allegedly Anticipated by
Crotzer, WO '887, Shallig and JP 6-38912

Claims 13-16 and method analogues 44-47 are cancelled herewith. Amended claims 17-31 recite a debris sensor "responsive to a debris strike to generate a first signal indicative of such strike" and "a processor operable to process the first signal to generate a second signal representative of a quantitative characteristic of debris being collected by the cleaning apparatus." Amended claims 48 *et seq.* are the method analogues of claims 17 *et seq.* and thus all contain the "debris strike" and related recitations. The use of a piezoelectric sensor "responsive to a debris strike to general a debris signal indicative of such strike", in combination with processing the debris signal to generate a second signal representative of a quantitative characteristic of debris being collected, is neither taught nor suggested by the art of record. To establish this point, each of the cited references will next be discussed.

Crotzer discloses a dust sensing apparatus using a PVDF transducer element oscillating at a resonant frequency to detect changes in dust concentration. There is no disclosure of particular uses or applications of the device, and in particular, no teaching or suggestion of its use in a robotic vacuum cleaner. Moreover, there is no disclosure or teaching of sensitivity to debris strikes – instead, the teaching is of a transducer that is sensitive to the "quantity of dust on the sensor" (col. 2, ll. 38-45). Still further, given that the transducer measurement is based on the damping effect of dust ("as dust presence dampens the oscillation frequency, a feedback circuit increases the voltage to drive the oscillation frequency back toward resonance" (col. 2, ll. 8-13)), this reliance on "damping" actually teaches away from sensitivity to debris strikes. Beyond this, given the reliance on damping, it is unclear whether this device would be suitable for use in a high-vibration environment such as a vacuum cleaning device.

WO 95/30887 (German-language specification, English-language abstract) appears to disclose a method of detecting particles in a two-phase stream (such as in a vacuum cleaner), and a vacuum

cleaner utilizing such method. A piezoelectric sensor (20, FIG. 1) is used to determine the location and size of the particles, and a signal generated by the piezoelectric sensor is used to control or adjust the suction power of a vacuum cleaner. As discussed below, there is no teaching or suggestion in the abstract and drawings of its use in combination with a processor capable of changing operative modes in response to a debris signal indicative of debris strikes, wherein the change may include reducing the speed of movement of the apparatus; or of processing the first signal to generate a second signal representative of a quantitative characteristic of debris being collected.

Schallig et al. discloses an electrical surface treatment device (such as a vacuum cleaner) with an acoustic (piezoelectric) "surface type" detector. The detector is suitable for determining whether a surface to be cleaned is a hard, smooth floor or a carpet. (Col. 2, ll. 15-21; col. 6, ll. 60-63.) There is absolutely no disclosure or suggestion of a piezoelectric sensing device for detecting debris strikes, or of its use in combination with a processor capable of changing operative modes in response to a debris signal indicative of debris strikes, wherein the control may include reducing the speed of movement of the apparatus; or of processing the first signal to generate a second signal representative of a quantitative characteristic of debris being collected.

Japanese 6-38912, for which no English-language translation has been provided, appears to disclose the use of a piezeoelectric sensor (4, FIG. 2) in a vacuum cleaner conduit (2, FIGS. 1 and 2). Without more, it is not clear from the drawings precisely what use is made of the output signals, but there appears to be no teaching or suggestion of its use in combination with a processor capable of changing operative modes in response to a debris signal indicative of debris strikes, wherein the change may include reducing the speed of movement of the apparatus; or of processing the first signal to generate a second signal representative of a quantitative characteristic of debris being collected.

The Hoekstra patents, assigned to Electrolux Corporation, disclose electronic vacuum cleaner control systems, in which "an optical dust sensor . . . monitors the frequency with which dust particles flow into the vacuum cleaner [and] the control system can automatically adjust the power setting of the vacuum cleaner based on the measured frequency." (Abstract; col. 2, ll. 30-40; col. 5, ll. 7-52; col. 7, ll. 4-53.) There is no disclosure of the use of a piezoelectric sensing device responsive to debris strikes for generating a debris signal indicative of such strikes; and the disclosed device is subject to all the problems noted in the specification of the present application for patent with regard to optical dust sensors. There is also no teaching or suggestion of its use in combination with a processor capable of changing operative modes in response to a debris signal indicative of debris strikes, wherein the change may include reducing the speed of movement of the apparatus; or of processing the first signal to generate a second signal representative of a quantitative characteristic of debris being collected.

In summary, the cited references do not teach a cleaning apparatus having "a piezoelectric sensor . . . responsive to a debris strike to generate a debris signal indicative of such strike" in combination with "a processor operable to process the first signal to generate a second signal representative of a quantitative characteristic of debris being collected by the cleaning apparatus" or a processor capable of changing operative modes in response to the debris signal indicative of debris strikes, wherein the change may include reducing the speed of movement of the apparatus. Accordingly, the cited references do not teach or suggest the claimed combinations of features.

III. Rejection of Claims 4, 10-11, 35, and 41-42 35 U.S.C. 103(a)
as being allegedly unpatentable over Kawakami '261
in view of Hoekstra '146 or '572

Claims 4, 10, 35 and 41 of the present application for patent recite a debris sensor comprising spaced-apart first and second debris sensing elements respectively operable to generate first and second debris signals; wherein the processor is responsive to the respective first and second debris signals to select a pattern of movement. Claims 11 and 42 as amended add the further recitation of responding to differences between the first and second debris signals to steer the device in the direction of debris.

Claims 4, 10, 35, 41: Kawakami contains no teaching or suggestion of a processor that is responsive to respective first and second debris signals to select a pattern of movement. Firstly, as discussed above, Kawakami contains no teaching or suggestion of the idea of a processor selecting a pattern of movement. Secondly, Kawakami contains no teaching or suggestion of a processor that is responsive to respective first and second debris signals generated by spaced-apart first and second debris sensors. There is no teaching or suggestion in Kawakami that its processor might respond, for example, to different respective signals generated by a first and second photocell -- for any purpose, let alone for selecting a pattern of movement (particularly since the concept of selecting a pattern of movement is absent from Kawakami).

The proposed combination of the Hoekstra patents to the teachings of Kawakami - - even if there were some suggestion of so combining, which there is not - - does not change the analysis. The Hoekstra patents disclose "an optical dust sensor [that] monitors the frequency with which dust particles flow into the vacuum cleaner [and] the control system can automatically adjust the power setting of the vacuum cleaner based on the measured frequency." Nothing in Hoekstra teaches or suggests a processor that responds to different respective signals generated by first and second sensors to select a pattern of movement.

Accordingly, the cited references, taken separately or in combination, do not teach or suggest the combination of features recited in claims 4, 10, 35 and 31.

Claims 11 and 42: With the addition of the concept of responding to differences between the first and second debris signals to steer the device in the direction of debris, the differences over the prior art are even greater. First, Kawakami contains no teaching or suggestion of steering, let alone steering in the direction of debris based on the differences between signals generated by spaced-apart first and second sensors. There is no indication that Kawakami's processor can even respond to different respective signals generated by, for example, first and second photocells. And again, the proposed combination of the Hoekstra patents does not change the analysis. The cited references, taken separately or in combination, do not teach or suggest the claimed combination of features.

IV. Rejection of Claims 5 and 12 under 35 U.S.C. 103(a)
as being allegedly unpatentable over Kawakami '261 in view of Hoekstra
taken with Crozter, WO 95/30887, Schallig, and JP 6-38912

Claims 5 and 12, including the limitations of their respective independent parent claims, recite the combination of (1) a processor capable of controlling the drive system to provide at least one pattern of movement, (2) a debris sensor comprising a piezoelectric sensor element located proximate to a cleaning pathway of the cleaning apparatus and responsive to a debris strike to generate a signal indicative of such strike, and (3) a processor that is responsive to the signal indicative of a debris strike to either select a pattern of movement (claim 5) or an operative mode (claim 12).

The cited references, taken separately or in combination, do not teach or suggest this claimed combination. Kawakami, for example, does not teach or suggest patterns of movement, or a processor capable of selecting a pattern of movement, or a sensor capable of generating a signal indicative of a debris strike, or a processor responsive to a signal indicative of a debris strike.

While Hoekstra teaches an optical dust sensor for changing power settings, there is no suggestion in either reference to use a piezoelectric sensor to detect debris strikes and use the resultant signal to select an operative mode or a pattern of movement.

Crotzer, as noted above, relies upon damping from an accretion of dust, and thus teaches away from the idea of using a piezoelectric sensor to generate a signal indicative of debris strikes. Even if there were some suggestion in Crotzer (and there is not) to combine its teachings with Hoekstra and Kawakami, this combination would not result in or suggest the referenced claims.

Similarly, while the WO '887 teaches a piezoelectric sensor to control power settings, there is no teaching or suggestion of a processor capable of controlling a drive system to provide at least one

pattern of movement, and there is thus no suggestion of combining this reference with Hoekstra or Kawakami.

Schallig, which teaches the use of a piezoelectric sensor to determine whether a floor is either hard or carpeted, similarly contains no suggestion of making such a combination, and even if the combination of Schallig, Hoekstra and Kawakami were made, the result would not teach or suggest the claimed combination.

Finally, with regard to JP '912, it is unclear exactly what use is made of its piezoelectric signals, but there does not appear to be a single drawing that teaches or suggests the idea of a processor that is both capable of controlling the drive system to provide at least one pattern of movement, and responsive to a debris signal to either select a pattern of movement or an operative mode.

In this regard, it is noted that the functions of the LED/photocell emitter/receivers in Kawakami could not be provided using a piezoelectric debris strike sensor. First, Kawakami's optical elements are there to sense the dirtiness of a floor to be cleaned, rather than to detect debris strikes from particulates already collected. Secondly, Kawakami's optical sensors are there to "look ahead" and tell the wet scrubber, before it encounters an area of higher levels of soil, that it needs to enter the "careful cleaning" mode. These functions could not be provided by a piezoelectric debris strike sensor responsive to debris strikes by particulates already collected, and thus, it would not have been obvious to combine the teaching of those references showing a piezoelectric sensor with those of Kawakami.

Accordingly, the cited references, taken separately or in combination, do not teach or suggest the combination of features recited in claims 5 and 12.

V. The Colens Patents Do Not Teach Use Of Debris Sensing to Steer Toward Debris, Do Not Teach Differential Processing of Different Debris Signals; or the Use of Piezoelectric Sensing

Applicants on October 27, 2004 filed a Supplemental Information Disclosure Statement providing a copy of two patents to Colens: U.S. Patent Nos. 6,532,404 and 6,389,329, which disclose an optical dust detector in a suction inlet of a robotic vacuum cleaner, and a method for changing movement pattern based on detected dust levels. See e.g., col. 9 of Colens '404. Colens teaches that "if the dirty surface is small", then the machine can "decrease its speed"; if the dirty surface is "more important", the machine "carries out a back and forth movement"; and if the dirty surface is "sufficiently important" then the machine "returns in one systematic mode of cleaning as described in FIG. 8." See col. 9 of Colens '404.

However, Colens does not teach or suggest the use of debris sensing to steer the device toward debris (a back and forth movement upon sensing of debris is not a teaching of steering the device in the direction of debris, or more particularly, in the direction of increasing debris), nor does it teach the use of piezoelectric sensing, or the use of spaced-apart first and second piezoelectric sensors to enable differential processing of different debris signals. The subject matter of the amended claims is therefore not taught or suggested by Colens, taken separately or in combination with the other patents referenced above.

VI. Conclusions:

The other art made of record and not relied upon is not considered to detract from the patentability of the claims.

The present response is deemed to attend to each point raised in the outstanding Action. The present response amends the claims to more particularly claim features of the present invention. No new matter has been added, and support for the new claims is found in the specification and drawings as filed. The Examiner is respectfully requested to allow the claims and pass the application through to issuance. Should questions arise, the Examiner is respectfully invited to contact the undersigned.

Respectfully submitted,

Date: December 7, 2004

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